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Original Research Article

Spectrum of pediatric urinary stone composition in North Western India: analysis at tertiary care center

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ABSTRACT

Background: Pediatric urolithiasis results in significant morbidity in later life. Incidence as well as site and chemical composition of calculi varies according to the changes in socio-economic conditions over time and the subsequent changes in dietary habits leading to a marked variation in the spectrum of urinary stone composition. To evaluate the spectrum of urinary stone composition in pediatric population from North-western India.
Methods: This was a prospective observational study conducted between October 2013 and February 2019 which included pediatric patients with urolithiasis. Demographic and epidemiological characteristics including age, sex, geography, religion, socio-economic status, dietary habits were recorded. The location and sizes of stones were documented. The data was collected, analyzed and presented using summary statistics.
Results: A total of 163 patients with urolithiasis were enrolled, of which 86 (53%) aged between 6 and 10 years, 49 (30%) aged between 11 and 14 years and 28 (17%) were aged between 0 and 5 years. The majority of patients were male (n=134; 82.21%). The most common location of the stone was urinary bladder (n=106; 65.03%) followed by kidney (n=33; 20.25%), urethra (n=16; 9.82%) and ureter (n=8; 4.91%). The upper tract (kidney and ureter) to the lower tract (bladder and urethra) stone ratio was 1:4. Stones with mixed composition were more than pure stones (73.62% versus 26.38%). The most common composition was the mixed stone of calcium oxalate, calcium phosphate and uric acid (n=36; 22.09%) followed by mixed stone of calcium oxalate monohydrate and dihydrate with uric acid (n=29; 17.79%), calcium oxalate and uric acid (n=25, 15.34%), calcium oxalate and calcium phosphate (n=20; 12.27%). Calcium oxalate was present in 80% of the stones, followed by uric acid in 7%, struvite in 6%, cystine in 3% and calcium phosphate in 2%.
Conclusions: These results suggest that the prevalence of mixed stones with calcium oxalate as the predominant chemical component in the urinary stones of pediatric patients studied.

Keywords: Calcium oxalate, Fourier transform infrared, Pediatric urolithiasis, Stone morphology

INTRODUCTION

Urolithiasis is a common urological problem which is characterized by high recurrence rate, high burden on healthcare system and the society. Hence, strategies that help in identification of stone composition and appropriate prevention reducing its recurrence are appreciated, particularly in children, given the increased

lifespan in this population. Pediatric urolithiasis results in significant morbidity in later life.[1,2]

Understanding the composition helps us to take appropriate preventive measures. This approach is important when stones have been diagnosed in pediatric age group. The many years of life ahead for these pediatric patients, they deserve a thorough educative process, which also becomes more rewarding. Unfortunately, there is paucity in the literature regarding the pediatric stone composition.[3]

There is marked variation in the spectrum of urolithiasis between children from developed and developing countries.[4-6] Bladder stones being more common in developing countries compared to developed world where renal stones predominate. As the economic status of a country gets uplifted there is a change noted in pediatric stone composition with preponderance of upper urinary tract.[6-8] The change becoming more akin to adult variety.

Evaluation of renal calculi along with blood and urine examination may help to understand possible cause and risk factors, which may help in avoiding recurrence. Though there are several methods for the evaluation of renal calculi Fourier transform infrared (FTIR) spectroscopy, X-ray diffraction crystallography, coherent -scatter analysis, etc., FTIR is considered more useful and accurate owing to its sensitivity and specificity.[9,10] This paper presents the results of a study that evaluated the spectrum of urinary stone composition in pediatric population from North-western India.

METHODS

This was a prospective study conducted at Department of Surgery, Dr. S. N. Medical College, Jodhpur, Rajasthan, India between October 2013 and February 2019. All pediatric patients aged less than 18 years diagnosed with urolithiasis and operated at our institution were eligible to participate. Patients aged more than 18 years, patients or their parents who refused to provide consent, patients with renal anatomical deformity were excluded from the study. The study protocol and related documents were reviewed and approved by the institutional ethics committee.

The study was conducted in accordance with good clinical practices and the ethical principles that have their origin the Declaration of Helsinki. Each study participant aged more than seven years provided written informed assent along with written informed consent of their parents or guardians. For participants aged less than seven written informed consents of their parents or guardians were obtained.

Patients were screened and if eligible were included in the study and the patient data sheets were analyzed for the various epidemiological factors including age, sex, geography, religion, location of stone, socio-economic status, dietary habits, and total number of hospital admissions. The location and the sizes of stones were documented with ultrasonography of kidney ureter bladder (USG-KUB) along with an X-ray KUB or intravenous pyelography (IVP), as deemed appropriate.

Patients were considered for surgery who were most suited based on stone location and stone burden. Surgical options included were suprapubic cystolithotripsy (SPCL), percutaneous cystolithotomy (PCCL), ureteroscopic lithotripsy (URSL), and mini-PCNL.

The stones recovered from surgery were washed with distilled water to remove particles attached, dried with filter paper, and then were cut for microscopic structural analysis. To prepare the renal stones for analysis, first they were grinded to a fine consistency (using a mortar and pestle) and next dried in a hot air oven for 24 h at 100°C. Powder form was converted into a pellet by first mixing 0.003 mg of the dried powder with 0.097 mg of potassium bromide powder and then this mixture was transferred to the mini hand press to form pellet which was subsequently transferred onto the spectrophotometer pellet holder for further analysis.

Stone composed of more than 90% of the reported composition was considered as pure stone; however, stones that were made of more than one composition (none of the compositions was more than 90% of the total) were considered as mixed. If the one of the compositions was more than 50% of the total it was considered as predominant. There was sample size calculation employed for this study. The data was collected, analyzed and presented using summary statistics.

RESULTS

A total of 1086 renal stones were operated during the study period, of which 163 (15.01%) stones were operated in children less than 14 years of age. Of the total 163 pediatric patients, the majority of patients (86; 52.76%) belonged to the age group of 6 to 10 years, 28 (17.18%) patients belonged to the age group of 0 to 5 years and 49 (30.06%) patients belonged to the age group of 11 to 14 years.

Out of 163 patients, 134 (82.21%) patients were males whereas 29 (17.79%) were females giving a male to female ratio of 4.62:1. Overall, the mean (SD) age was 8.26 (1.18) years.

The commonest religion was Hindu with 114 (69.94%) patients, which was also most common in all three groups. There were 35 Muslim (21.47%), nine Christian (5.52%) and five Sikh (3.07%) patients (Table 1).

Table 1: Demographics and clinical characteristics.

Parameter, n (%)	Age			Total (N=163)
	0-5 years (n=28)	6-10 years (n=86)	11-14 years (n=49)	
Sex				
Male	22 (78.57)	72 (83.72)	40 (81.63)	134 (82.21)
Female	6 (21.43)	14 (16.28)	9 (18.37)	29 (17.79)
Male: female ratio	3.66:1	5.14:1	4.44:1	4.62:1
Religion				
Hindu	14 (50.00)	61 (70.93)	39 (79.59)	114 (69.94)
Muslim	11 (39.29)	19 (22.09)	5 (10.20)	35 (21.47)
Christian	2 (7.14)	4 (4.65)	3 (6.12)	9 (5.52)
Sikh	1 (3.57)	2 (2.33)	2 (4.08)	5 (3.07)
Location of the stone				
Kidney	3 (10.71)	13 (15.12)	17 (34.69)	33 (20.25)
Ureter	0	2 (2.33)	6 (12.24)	8 (4.91)
Urinary bladder	25 (89.29)	65 (75.58)	16 (32.65)	106 (65.03)
Urethra	0	6 (6.98)	10 (20.41)	16 (9.82)

Of the total 163 patients, the commonest location of the stone was urinary bladder (n=106; 65.03%) followed by kidney (n=33; 20.25%). Eight (4.91%) patients had stones in ureter and 16 (9.82%) patients had stones in urethra. The upper tract (kidney and ureter) to the lower tract (bladder and urethra) stone ratio was 1:4. The majority (n=120; 73.62%) of the patients belonged to the lower- and middle-class socio-economic status. The diet was mainly cereal based, consisting of chapattis (made of wheat) and/or polished rice. The amount of animal proteins in the diet was low. There was no evidence or gross malnourishment of vitamin deficiency in any of these patients.

Stones with mixed composition were most common than stones with pure composition (73.62% versus 26.38%) (Table 2). The most common composition was the mixed stone of calcium oxalate, calcium phosphate and uric acid (n=36; 22.09%) followed by mixed stone of calcium oxalate monohydrate and dihydrate (n=29; 17.79%), calcium oxalate and uric acid (n=25, 15.34%), calcium oxalate and calcium phosphate (n=20; 12.27%). Calcium oxalate was present as a predominant composition in 80% of the stones, followed by uric acid in 7%, struvite in 6%, cystine in 3% and calcium phosphate in 2% of stones. On subgroup analysis, stones composed of calcium oxalate, calcium phosphate and uric acid were common among all groups.

Table 2: Distribution of patients according to stone composition.

Stone composition, n (%)	Pure/ Mixed	0-5 years (n=28)	6-10 years (n=86)	11-14 years (n=49)	Total (N=163)
Calcium oxalate + calcium phosphate + uric acid	Mixed	8 (28.57)	16 (18.60)	12 (24.49)	36 (22.09)
Calcium oxalate monohydrate + calcium oxalate dihydrate	Mixed	6 (21.43)	12 (13.95)	11 (22.45)	29 (17.79)
Calcium oxalate + uric acid	Mixed	4 (14.29)	13 (15.12)	8 (16.33)	25 (15.34)
Calcium oxalate + calcium phosphate	Mixed	5 (16.86)	9 (10.47)	6 (12.24)	20 (12.27)
Calcium oxalate monohydrate	Pure	1 (3.57)	10 (11.63)	5 (10.20)	16 (9.82)
Uric acid	Pure	2 (7.14)	8 (9.30)	1 (2.04)	11 (6.75)
Struvite + calcium phosphate	Mixed	0	8 (9.30)	2 (4.08)	10 (6.13)
Calcium oxalate dihydrate	Pure	1 (3.57)	5 (5.81)	2 (4.08)	8 (4.91)
Cystine	Pure	1 (3.57)	3 (3.49)	1 (2.04)	5 (3.07)
Struvite	Pure	0	2 (2.33)	1 (2.04)	3 (1.84)

DISCUSSION

Incidence as well as site and chemical composition of calculi vary according to the changes in socio-economic conditions over time and the subsequent changes in dietary habits leading to a marked variation in the spectrum of urinary stone composition. This has been attributed to various factors such as improved nutritional standards, especially increased proteins: cereals ratio and better living standards.[11] In the developing countries there

still persists increased incidence of vesical calculus as reported from Thailand, Indonesia etc.[5, 12,13]

The predominantly cereal based diets with very little animal proteins contribute to this high incidence.[4,5,14] It is also reported that frequent diarrhea leading to dehydration may contribute in the formation of calculi owing the concentrated acidic urine.[14] However, presence of severe protein energy malnutrition in children with vesical calculus is not a frequent occurring as reported in previous multiple studies. Srivastava et al found only 6 out of 132 pediatric stone patients from Afghanistan suffering from mild degree of protein energy malnutrition.[11] The diet in our region is mainly cereal based which combined with hot climate and reduced water intake as contributing factors for increased stone burden. Also practice of prolonged breast feeding is common in the poor income group patients. The human breast milk, in contrast to cow's milk, is very low in phosphorus, as is polished rice. Such low phosphorus diets result in high peaks of urinary ammonia excretion, increasing the chances of stone formation.[5]

In the present study, out of total 163 patients, 134 (82%) patients were male with 29 (18%) female patients giving a male to female ratio of 4.62:1. However, in previous report from the United States the ratio was found to be 0.77:1.[15] Studies from other developing countries match that of ours Halstead reported a ratio of 10:1 in Thailand 13; Thalut et al found a sex ratio of 12:1 in favor of males from Indonesia.[5] Two other studies have reported male: female ratios as high as 20:1 from Syria and China.[16-17]

Muslims have been found to have a higher incidence of stones than Hindus in some Indian studies.[18-20] In the present study Hindu: Muslim ratio was 3.2:1. This is consistent with the ratio of Hindus and Muslims in the general population.

During the present study the total of 1086 patients with renal stone disease operated of which pediatric stone disease were 163 patients, emphasizing that a good significant proportion of renal stone disease 15% has early age (</=14 years) presentation, this compared to a developed country like USA were pediatric urinary calculi constitute 2% to 3% of all urinary calculi.[21-23]

In the present study, the proportion of calcium oxalate stone was increasing while that of uric acid, struvite, and cystine was decreasing with age in all parts of the urinary tract which was similar to findings reported by Gabrielsen et all from USA.[15]

Bladder stones were the commonest site of urolithiasis in children in the present series. Gaur et al found 131 out of 200 stones to be vesicle, Kabra et al, reported that out of 1,144 stones, 721 were bladder stones.[24,25] Other studies from India, Thailand Indonesia and Afghanistan [11] have also corroborated this.[5,12,13,26,27] In future, with improving standards of living and increased amounts of animal proteins in diet, this endemicity of bladder stones may disappear in India, especially in the urban populations. The rich socio-economic class of the major Indian cities already has western pattern of urolithiasis.

Stone analysis is recommended by AUA, EUA helping in the management to reduce stone recurrence. Urinary stone composition varies across the world and calcium oxalate stones are found to be the most predominant composition. Pediatric patients show different stone profile than adults. Very scanty data of pediatric stone composition are available in Indian literature. Ansari et al analyzed 1050 urinary stones recovered from patients in Northern India and found that calcium oxalate was the most predominant component present in 93.04% of the cases followed by struvite in 1.42%.[3] Similar results have been reported from different parts of India as is the finding in our study.[25,28,29]

CONCLUSION

These observations indicate the prevalence of mixed stones with calcium oxalate as the predominant chemical component in the urinary stones of pediatric patients from North-western India. The incidence of pediatric stone disease in our population can't be ignored. Recurrence of stone disease is a very common phenomenon and hence subjecting a proper stone analysis in cases of renal stone disease especially more in a pediatric stone disease would help us manage the patient more appropriately, with valuable guidelines especially regarding the etiological factors going a long way to help reduce the recurrence and the morbidity that comes with this disease.

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