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Surgery Section

Metabolic Evaluation in Paediatric Urolithiasis: A 4-Year Open Prospective Study

AJAY KUMAR R GAJENGI[1], VINAYAK GORAKHNATH WAGASKAR[2], HARSHWARDHAN V TANWAR[3], SUNIL MHASKE[4], SUJATA K PATWARDHAN[5]

ABSTRACT

Introduction: Children with urolithiasis are associated with considerable morbidity and commonly associated with metabolic abnormalities. By treating these abnormalities stone formation is prevented.

Objectives: To study the metabolic risk factors of urolithiasis in children and compare them with literature.

Materials and Methods: In open, prospective and observational study, 75 children were evaluated from August 2010 to June 2014. In all patients' dietary history, water intake and results of laboratory findings were recorded. All urine samples obtained from patients were without dietary restrictions. Reference paediatric 24 hour urinary parameter was used according to western literature.

Results: We investigated 75 patients with urolithiasis. Low urine volume was found in 49 patients which is comparable with previous studies indicating simple intervention as to increase water intake. Low calcium intake was found in 44 patients suggesting that low calcium intake is associated with higher incidence of urolithiasis due to increased intestinal oxalate absorption. Hypocalcaemia was found in 32 patients and 24 hour urinary abnormality was found in only 16 patients'. Both these finding does not support previous literature. Stone analysis finding does not correlate with urinary finding.

Conclusions: Low urine volume secondary to low water intake is predominant finding. Hypocalcaemia is major metabolic abnormality in contradiction to western literature. There are no nomograms for urinary excretion of Calcium, uric acid, oxalate and citrate in Indian children. Keeping the optimum blood calcium level & increased fluid intake can prevent stone formation in children.

Keywords: Hypocalcaemia, Hypercalciuria, Urine volume, Urinary tract infections

INTRODUCTION

Urolithiasis is less common in children than in adults [1]. The incidence in children is generally about 2-3% [2]. However its incidence, composition, location and clinical characteristics vary greatly from one country to another [3]. This wide geographic variation is related to climatic, dietary and socioeconomic factors. Genetic inheritance, nutrition, metabolic abnormalities, environmental factors, anatomical characteristics, and calculus-inducing medication are the factors predisposing for urolithiasis in children [1].

The metabolic evaluation for urolithiasis helps us to identify children those at increased risk for recurrent stone disease and also to diagnose specific treatable metabolic derangements. Surgically removed stones or isolated from strained urine during spontaneous passage, when subjected to compositional analysis is helpful to guide the workup and to determine the underlying pathologic processes. In addition to verifying the major molecular components, compositional analysis can define mixed stone types and the specific forms (e.g., calcium oxalate monohydrate versus calcium oxalate dihydrate). Spot urine and serum testing is combined with 24-h urine analysis to comprehensively assess a child's metabolic risk for recurrent stone disease [4].

By early diagnosis and treatment of these risk factors, future stone formation may be prevented. This study analyses these factors. At present there are no studies for metabolic evaluation in renal stones in paediatric population in India. In a developing country like India, this issue needs to be considered and some guidelines have to be made based on that. Our intent to publish the data is that physicians will be aware of the reality and same study can be used to set guidelines in late race.

AIMS AND OBJECTIVES

To study the metabolic risk factors of urolithiasis in children. To compare these factors like 24 hours urinary pH, volume, calcium, oxalate, citrate, uric acid, creatinine along with biochemical investigations like Serum calcium, Serum phosphorus, Serum creatinine, Serum uric acid, Serum electrolytes, Serum Parathyroid hormone and Serum albumin with literature.

MATERIALS AND METHODS

The study was an open, prospective and observational study and all children below 12 years with stone disease were included. Institutional Ethical Committee clearance was taken. We analysed 75 consecutive patients with urinary calculi referred to the Department of Urology, Kings Edward Memorial hospital, Mumbai, India from August 2010 to June 2014. Diagnosis of stone disease was confirmed by Ultrasonography and Intravenous pyelography and Computed Tomography in selected cases. Medical records were reviewed for clinical and laboratory data including gender, age at diagnosis, presence of urinary tract anomalies, and Urinary Tract Infections (UTI) in the form of urinalysis, urine culture and complete blood count. In children with UTI, metabolic evaluation was performed after treatment and only after confirmation of clear urinalysis and culture report they were included in the study. In all patients' dietary habits, water intake per day over past 3months and results of laboratory findings were recorded. In infants and non-toilet-trained patients, a random urine sample had been checked and in toilet-trained patients, 24-hour urine had been collected for the measurements listed below. All urine samples obtained from patients were without dietary restrictions. Urine tests included urinalysis, urine culture, 24 hours urinary pH, volume, calcium, oxalate, citrate, uric acid, creatinine. Biochemical investigations

included Serum calcium, Serum phosphorus, Serum creatinine, Serum uric acid, Serum electrolytes, Serum Parathyroid hormone and Serum albumin.

Patients with UTI on urine analysis, previously diagnosed metabolic, endocrine, gastrointestinal disorder, Protein Energy Malnutrition, on Calcium, Vitamin D, and Vitamin C supplementation were excluded from the study.

RESULTS

[Table/Fig-1] shows paediatric 24 hour urinary parameter according to western literature [1]. Total 75 children were evaluated with 53(70.66%) being male and 22(29.33%) female. Thirty five patients (46.66%) were below five years. Forty-four children (59%) had low Calcium intake and only 12 patients (15%) had high calcium intake computed on dietary habits while 49 children (65%) had low water intake and hence low 24 hour urine volume.

Metabolic abnormality was found in 48 patients (64%) out of which 32 had serum abnormality and 16 had 24 hour urinary metabolic abnormality. Twenty eight children had hypocalcaemia with normal PTH and four had secondary hyperparathyroidism [Table/Fig-2].

Hypocitruria is the most common urinary abnormality found in eight patients followed by hypercalciuria in five patients [Table/Fig-3].

Stone analysis was done in 30 patients with majority having calcium oxalate stones [Table/Fig-4].

Normal 24 hour	Urinary value
Calcium	< 4 mg/kg/day
Oxalate	< 0.57 mg/kg/day
Citrate	> 6 mg/kg/day
Uric acid	< 10 mg/kg/day
Urine volume	> 1ml/kg/day

[Table/Fig-1]: Paediatric 24 hour urinary parameter according to western literature [1].

Serum abnormility	No of patient(32)
Hypocalcaemia	28(88%)
Hypocalcaemia+hyperphosphataemia	03 (9%)
Hypercalcaemia	00 (00%)
Hyperuricaemia	01 (3%)

[Table/Fig-2]: Serum abnormality.

Urinary metabolic abnormality	No of patients (16)
Hypercalciuria	05(31%)
Hyperoxaluria	01 (6%)
Hypocitruria	08 (50%)
Hyperuricosuria	02 (12%)

[Table/Fig-3]: Urinary metabolic abnormality.

Type of stone	No of patients (30)
Calcium oxalate	16(54%)
Calcium phosphate	04(14%)
Uric acid	05(17%)
Cystine	01(4%)
Struvite	04(14%)

[Table/Fig-4]: Stone analysis.

DISCUSSION

In paediatric population, metabolic and genitourinary anomalies which predispose to urolithiasis often co-exist. It accompanies with considerable morbidity such as urinary tract infection (UTI), obstruction, scarred kidney, hypertension and progressive deterioration of renal function. UTI affects 8-45.9% of children with urolithiasis [5,6]. In children below five years of age, UTI accounts for 62% of urolithiasis [7,8]. Screening of all children with stone for metabolic risk factors is essential [9]. In our study low calcium intake was found in majority of patients (59%) suggesting low calcium intake is associated with higher incidence of urolithiasis. Low calcium intake causes urolithiasis by two mechanisms. Low calcium intake probably led to an increase in available intestinal oxalate and this limitation in dietary calcium may subsequently increase oxalate absorption, thereby raising the super saturation of calcium oxalate but in our study only one patient had low calcium intake and associated hyperoxaluria. Low calcium intake stimulates calcitriol production which causes hypercalcaemia which inhibits PTH production and causes hypercalciuria [10]. In our study only five children had hypercalciuria and none had hypercalcaemia

In 49 patients there is associated finding of low urine volume suggesting low urine volume is contributory finding in these patients. In a review of a large cohort by Curhan et al., 1997 revealed that there was a decreased incidence of nephrolithiasis in those subjects who had increased levels of dietary calcium there is possibility of intermittent hypercalcaemia which was not detected in present sample size [11]. Low water intake and low urine volume is major finding and is comparable to previous literature.

Borghi L et al., found that stone risk factor in nephrolithiasis is urine volume and for prevention of stone recurrences, large intake of water is the initial therapy [12]. Therefore, the treatment of all children with urinary stones starts with the recommendation to maintain a high oral fluid intake and mothers are instructed to give adequate water so as morning sample of urine remains pale yellow or straw colour.

The usual causes of hypocalcaemia related to diet are low calcium intake, high intake of phosphates, low magnesium. Cause of hypocalcaemia in our study is low calcium intake. It is difficult to find correlation between hypocalcaemia and urolithiasis as majority of the patient had associated low water intake and urine volume.

The most contradictory finding in our study is 24 hour urinary abnormality found only in 21% patients, though hypocitruria as most common urinary abnormality in these patients is comparable with previous literature. Naseri et al., in series of 144 patients, 54% patients had urinary metabolic abnormality [13]. Erbagci et al., in his series of 95 patients found urinary metabolic abnormality in 90% of patients with hypocitruria most common abnormality [3]. The cause of this contradictory finding may be normal reference 24 hour urinary metabolic value which we have taken according to western literature as there is no Indian literature on normal reference 24 hour urinary metabolic value.

In our study stone analysis finding does not correlate with urinary findings that means out of 30 patients only eight had 24 hour urinary metabolic abnormality. Calcium oxalate stone was found in 16 patients and only five had hypercalciuria. Again cause of this contradiction is unknown which may be again 24 hour reference value which is causing the problem in correlation.

CONCLUSION

Keeping the optimum blood calcium level & increased fluid intake can prevent stone formation in children. Further studies are required to establish paediatric reference ranges for 24 hour urinary super saturation parameters in Indian population.

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PARTICULARS OF CONTRIBUTORS:
1. Senior Resident, Department of Urology, Seth G.S.M.C. and King's Edward Memorial Hospital, Mumbai, Maharashtra, India.
2. Senior Resident, Department of Urology, Seth G.S.M.C. and King's Edward Memorial Hospital, Mumbai, Maharashtra, India.
3. Senior Resident, Department of Urology, Seth G.S.M.C. and King's Edward Memorial Hospital, Mumbai, Maharashtra, India.
4. Senior Resident, Department of Urology, Seth G.S.M.C. and King's Edward Memorial Hospital, Mumbai, Maharashtra, India.
5. Professor and Head, Department of Urology, Seth G.S.M.C. and King's Edward Memorial Hospital, Mumbai, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Vinayak Gorakhnath Wagaskar,
8th Floor; Department of Urology, New Building, Sgsmc and Kem Hospital Campus, Parel, Mumbai-400012, India.
E-mail : vinayakwagaskar99@gmail.com.

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