Relationship between crystalluria and urinary calculi and associated urinary tract infection

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ABSTRACT

75 patients with renal colic and burning micturition are evaluated by the following investigations - microscopic urine examination, urine culture and sensitivity, X-ray KUB, U/S Scan, and IVP only if X-ray KUB was inconclusive. On Statistical analysis, out of 75 subjects with renal colic, 26 subjects had crystalluria, 27 subjects had urinary tract infection, and only 14 subjects had all the three parameters. This indicates that Crystalluria is an important predisposing marker for calculus formation and other urinary tract diseases but it also shows that it is not mandatory to have calculus in a subject with crystalluria since the formation of calculus is multifactorial. Urinary tract infection is a part of nephrocalcinosis although all the subjects may not suffer with infection.

Key words: crystalluria, renal stones, urinary tract infection.

INTRODUCTION

Renal stone disease has been recognized in many parts of the world. Renal stones are polycrystalline aggregates which are often associated with crystalluria and urinary tract infection. In most instances the precipitation of crystals occurs in little quantities.

Crystalluria is the excretion of crystals in urine, is a marker of transient supersaturation of urine present both in normal physiological and also in pathological conditions. Crystalluria depends on the saturation of salts, crystal inhibitor and promoter and crystal morphology, Ingestion of certain foods, changes of urine temp/pH, drugs. In some instances it is also associated with pathological conditions like urolithiasis, uric acid nephropathy. (1)

Crystals of size < 5mm pass out freely through the urinary tract, but the crystals of size >5mm precipitate and get obstructed in the passage leading to the calculus formation. Thus stasis is aggravated by abnormalities in urinary tract.

Infection has a dual role. Urea splitting organism promotes precipitation of phosphates and oxalates in alkaline media (2) Secondly, the sharp edges of oxalate calculi damage the urinary tract epithelium and encourage the growth of organisms by forming the nidus to the infectious agents. Persistent Urinary tract infection with urea splitting or non-splitting bacteria may be the initial factors in the synthesis of infection renal stones. In metabolic stones bacterial superimposition may be responsible for the recurrent urinary tract infections. A definite association is seen between urinary stones and urinary tract infection, positive cultures are not only found with struvite stones, but also with apatite and calcium oxalate stones, . Zanetti Get al (3).
The main objective of this study is to show the relationship between crystalluria and urinary stones and urinary tract infection. This is projected to show the role of crystalluria, which has a propensity for calculus formation but there are also subjects with asymptomatic crystalluria which means subjects without any symptoms or with only urinary tract infection. The study is aimed at showing the correlation between the frequency of symptomatic and asymptomatic crystalluria and associated urinary tract infection.

**MATERIALS AND METHODS**

The study is carried out on 75 subjects attending as out patients to the Department of General surgery in co-ordination with the Department of Microbiology, Bhaskar General Hospital, Yenkapally, Moinabad (m).R.R Dist. Andhra Pradesh, India, with complaints of renal colic and burning micturition, over a period of 2 months from June 1st, 2011 to July 31st, 2011.

Type of study: Prospective study with laboratory investigations

A specially designed proforma, containing the general information about the patient, symptoms and signs was filled for every patient included in this study.

Inclusion exclusion criteria: included in this study are both male and female patients with symptoms of renal colic and burning micturition.

All the subjects were informed about the implication and outcome of the study in their own language and a voluntary written consent is obtained.

After clinical examination, the subjects with renal colic and burning micturition are evaluated by the following investigations

- Microscopic urine examination (for demonstration of crystals)
- Urine Culture & Sensitivity (detects urinary tract infection)
- X-ray KUB-Kidney Ureter Bladder (detects radio opaque calculi)
- IVP Intravenous Pyelogram (demonstrates function of kidneys)
- U/S Scan abdomen (evidence of calculi)

Based on the above investigations, the subjects are divided into three groups.

Group A: comprising of subjects with crystalluria. These subjects are evaluated for urinary calculi & urinary tract infection.

Group B: Comprising of subjects with urinary calculi evaluated for crystalluria & urinary tract infection.

Group C: Comprising of subjects with crystalluria & Urinary tract infection evaluated for urinary calculi.

**Microscopic urine examination:**

It involves the collection of 10ml of clean catch mid stream first voided morning specimen of urine in a sterile wide mouthed container after taking necessary precautions.

The sample was analyzed in the laboratory after centrifugation at 2000 rpm for 5 minutes, after draining the supernatant, a drop of the sediment was placed on a clean glass slide covered it with the cover slip. Then was studied under normal microscope first under low power & then under high power lens. It can even be analyzed under contrast phase microscopy equipped with polarized filters for clear demonstration of crystals.
Interpretation of microscopic examination: it reveals the presence of pus cells, red blood cells, epithelial cells, crystals (4) casts.

**TYPE OF CRYSTAL**                    **APPEARANCE.**
- Calcium oxalate dihydrate – square envelop shaped
- Calcium oxalate monohydrate – hour glass shaped
- Magnesium ammonium phosphate – rectangular, coffin lid shaped
- Cysteine – hexagonal
- Uric acid – amorphous

**Urine for culture & Sensitivity:**
After instructing the patient, 10 ml of clean catch mid stream first voided morning specimen of urine in a sterile container after necessary precautions was collected. The sample was cultured on two media Mac Conkeys agar & Blood agar using semi quantitative or standard loop technique. After inoculation, the plates are incubated at 37°C overnight (6). A count above 100000 org/ml is considered as significant bacteriuria. (6)

The organism is identified by biochemical tests. Antibiotic sensitivity testing is done for the organisms by Kirby-Bauer disc diffusion method.

**X-ray KUB (Kidney Ureter Bladder):**
A plain film of abdomen is taken on an empty stomach with patient lying supine & bowel prepared

**Interpretation of the X-ray:**
Radio-opaque urinary calculi are detected. Renal stones are oval/ stag horn shaped present in the renal area in the lateral view on the vertebral body.

Ureteric stones (proximal, middle, and lower) lie along the course (line) of ureter. Bladder stones are oval/round in shape in centre / supra pubic in position. Composition of the stone (calculi) is determined only after it is removed from the body & analyzed biochemically.

**IVP- Intravenous Pyelogram:**
This procedure was advised only to those patients, in whom plain X-ray abdomen was inconclusive.

The procedure is done on an empty stomach with bowel prepared. The procedure involves the injection of water soluble radio contrast dye (7)(sodium diatrizoate – con ray safe dose 300mg) and serial films are taken at regular intervals, minimum 5 films are taken.

**Interpretation of IVP:**
It is useful in identifying obstruction thereby assessing the function of kidneys. It also demonstrates radiolucent calculi as filling defects of pelvis, bladder, calyces and in the ureter. It also demonstrates radio-opaque calculi of <2mm.
U/S Scan abdomen:
This is noninvasive investigation was advised with emphasis on urinary tract system, for the detection urinary calculi (8), hydronephrosis, site and size of radio opaque shadows, parenchymal thickness, structural abnormalities which are interpreted in terms of echo density of tissue in comparison to the surrounding tissues.

RESULTS AND DISCUSSION

In this study, Group A consists of 26 subjects with different types of crystals found on microscopic urine examination of urine sample which accounts to 34.64% . These subjects with crystalluria (n=26) when evaluated for the presence of calculus, 16 subjects were having calculus accounting for 61.53%. there by indicating that crystalluria is a potent and necessary initial step in the formation of kidney stones (urinary calculi) as reported by Michel Daudon et al (9)

Of the people with calculus, 7 people (43.75%) had bilateral calculi and 9 (56.25 %) had unilateral calculi. These subjects with crystalluria (n=26) when evaluated for Urinary tract infection, 14 were having the infection accounting to 53.84%.

(Considering 14 corresponding to 100%), it is found that infection of urinary tract by E.Coli accounted for 71.42%, Klebsiella constituted for 21.42%, Proteus constituted for 7.14%. (Table 1) which indicates, persistent urinary tract infection with urea splitting or non- splitting bacteria may be the initial factors in the synthesis of infection renal stones. In metabolic stones bacterial superimposition may be responsible for the recurrent urinary tract infections. It shows association between crystalluria and urinary tract infection.

Table 1 : Group A : Analysis of UTI causing organisms in crystalluria cases

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Number</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia coli</td>
<td>10</td>
<td>71.4</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>3</td>
<td>21.42</td>
</tr>
<tr>
<td>Proteus</td>
<td>1</td>
<td>7.14</td>
</tr>
<tr>
<td>Total</td>
<td>14 (18.66)</td>
<td></td>
</tr>
</tbody>
</table>

Group B:
Comprising of subjects with urinary calculi evaluated for crystalluria & urinary tract infection.
In this study, there were 75 subjects with calculus (n=75), when evaluated, 26 were having crystalluria accounting for 34.66%, 22 (out of these 26 crystalluric subjects) were found having calcium oxalate crystals accounting for 84.61%; 2 subjects (out of these 26 crystalluric subjects) were found having Triple phosphate crystals accounting for 7.69%. Another 2 subjects (out of these 26 crystalluric subjects) were found having Uric acid crystals accounting for 7.69% (Table 2) indicating that crystallization is required for stone (calculi) formation and stone formers have crystalluria. The stone growth rate depends on the number of crystals in suspension around the stone and to the crystal nucleation rate and negatively correlated to the crystal growth and the aggregation of crystals from the surrounding suspension was the dominant mechanism for stone enlargement as reported by Saw NK et al(10)

Table 2 : Group B: Number and features of crystals found in 75 subjects

<table>
<thead>
<tr>
<th>Crystal type</th>
<th>Number</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium oxide</td>
<td>22</td>
<td>84.61</td>
</tr>
<tr>
<td>Uric acid</td>
<td>2</td>
<td>7.69</td>
</tr>
<tr>
<td>Triple phosphate</td>
<td>2</td>
<td>7.69</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

Of the 75 subjects with calculi when evaluated, 27 were having urinary tract infection accounting for 36%. Of the 27 subjects with urinary tract infection. (Considering 27 corresponding to 100%) Infection with E.Coli is observed in 22 subjects accounting for 81.48%, infection with Klebsiella accounts for 14.81% (Table 3).Infection with proteus accounts for 3.70%. Urinary tract infection with E.Coli shows the conversion of commensal population into pathogenic organisms this may be due to decreased intake of water leading to the concentration of urine and also injury caused by the peculiar characteristics of the calculi (as for example calcium oxalate calculi has typical spiky
edges) to the urinary tract epithelium, thus forming a nidus for growth of bacteria thus acting as a good media for pathogenic organisms to grow.

Table 3: Group B: Calculi cases evaluated for UTI

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Number</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia coli</td>
<td>22</td>
<td>81</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>4</td>
<td>14.81</td>
</tr>
<tr>
<td>Proteus</td>
<td>1</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>

**Group C:**
Comprising of subjects with crystalluria & Urinary tract infection evaluated for urinary calculi. It was found that 14 subjects with crystalluria and urinary tract infection were having calculi which means only 14 subjects out of 75 were having all the three parameters accounting for 18.66%. These are the subjects who are grouped under symptomatic crystalluria as these subjects had almost all the symptoms of urinary tract infection like burning micturition, frequency and renal colic.

Where as, the individuals with only crystalluria complained of dull aching pain and few were even complaining of frequency. Hence the symptomatic patients with crystalluria account for 18.66% + 34.66% = 53.68% of the total subjects were classified under symptomatic crystalluria. The remaining 46.68% are placed under asymptomatic crystalluric individuals.

Urinary tract infection with certain bacteria plays an important role in the synthesis of renal stones. Infection stones are calculi that occur following urinary tract infections (UTIs) caused by urease-producing gram-negative organisms. They consist of magnesium ammonium phosphate, carbonate apatite and mono ammonium urate and alkaline urine is most favorable to their formation of these stones.

Apart from the 3 groups, we have also studied about the distribution of calculus in the subjects. It is found in this study that about 43.75% of the subjects have bilateral calculi and remaining 56.25% were found to have unilateral calculi.

Therefore the results of the study collaborated with other national and international studies. Since the sample size is 75 (small sample size) it is not possible to calculate “p” value. Therefore the values are calculated in percentages for Group A, B and C.

**CONCLUSION**

To conclude crystalluria is an important and necessary initial step in the formation of urinary calculi (renal stones) which means a respectable proportion of the population with crystalluria, ultimately turn out to be stone formers showing that crystalluria is an indicative of stone disease activity.

It is also observed that all the crystalluric individuals may not have symptoms associated with renal disease. Only those subjects who have calcium oxalate calculi by the virtue of their spiky edges which denude the urinary tract epithelium are prone to develop infection are symptomatic. Hence it is concluded that symptomatic and asymptomatic cases accounts to the same number, it is the morphology, size and peculiar characteristic of the calculi which is responsible for the symptoms and the demarcation of the crystal by various measures, can reduce the risk of stone formation and also the other associated symptoms.

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